DOCUMENT RESUME

ED 302 431 SE 050 293

TITLE	Science and Technology in School Curricula. Case Study 4: India.
INSTITUTION	United Nations Educational, Scientific, and Cultural Organization, Paris (France). Div. of Science, Technical and Environmental Education.
REPORT NO	ED-88/WS/50
PUB DATE	88
NOTE	22p.; Reproduced by permission of Unesco.
AVAILABLE FROM	UNESCO, 7 place de Fontenoy, 75700 Paris, France (price not available).
PUB TYPE	Reports - General (140)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Course Descriptions; *Educational Policy; Elementary Secondary Education; *Foreign Countries; International Educational Exchange; Mathematics Curriculum; Mathematics Education; Mathematics Instruction; Science and Society; Science Curriculum; *Science Education; Science Instruction; *Teacher Education; *Teaching Methods; *Technological Advancement
IDENTIFIERS	*India

ABSTRACT

A global survey was conducted by Unesco in 1986 on the place occupied by the teaching of science, mathematics, and technology, with the data indicating that mathematics and science are firmly entrenched in school curricula worldwide, but the place of technology is much more tentative. It was decided to probe more deeply into the adequacy of these curricula to meet national needs, and to undertake a study of their appropriateness in relation to the rapidly-evolving nature of science and technology. This case study concentrates on the work of the Rajasthan State Institute for Educational Research and Training. Rajasthan is involved with all aspects of the curriculum of the primary and secondary schools of the state but the focus of this document is on the areas of science, technology, and mathematics. It describes the role of the institute in such matters as curriculum development, low-cost equipment, teacher training, and informal schooling. (CW)

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Science and Technology in School Curricula

Case Study 4
India

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Science and Technology in School Curricula

Case Study 4
India

The Work of the State Institute of Educational Research and Training of Rajasthan, in the Field of Science Education

Unesco

Division of Science Technical and Environmental Education

ED-88/WS/50

Paris, 1988

Preface

In 1986, Unesco published a global survey on the place occupied by the teaching of science, mathematics and technology in school timetables[1]. The survey revealed that mathematics and science are firmly entrenched in school curricula world-wide, but that the place of technology is much more tentative. In all the ninety-seven countries which responded to the survey questionnaire, mathematics is taught at all school levels and science at most levels. Technology, however, is taught in relatively few countries. The survey also revealed a great diversity of emphasis on mathematics and science, from one country to another, in terms of the time allowance for these subjects.

To probe more deeply into the adequacy of science, mathematics and technology curricula to meet national needs, and their appropriateness in relation to the rapidly-evolving nature of science and technology themselves, a series of case studies were commissioned. This study concentrates on the work of one of the State institutes for educational research and training which are to be found all over India. The State institute chosen is that of Rajasthan in the north-western part of the subcontinent. The tasks remitted to the State Institute for Education Research and Training, Rajasthan cover all aspects of the curriculum of the primary and secondary schools of the State. This study, however, is devoted exclusively to the work of the Institute in the areas of science, technology and mathematics. It describes, albeit briefly, the role of the Institute in such matters as curriculum development, low-cost equipment, teacher training and a somewhat unusual range of other services, including services for whom formal schooling is not yet available.

The selection of material and the opinions expressed are those of the authors; they are not necessarily those of Unesco.

1 *The Place of Science and Technology in School Curricula: A Global Survey*. Paris, Unesco, 1986.

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Education in Rajasthan

Rajasthan is one of the states of the Sovereign Democratic Republic of India. It is situated in the north west of the country and is bounded on the west and north-west by Pakistan, on the north and the north-east by the States of Punjab and of Uttar Pradesh, on the south-east by the State of Madhya Pradesh and on the south-west by the State of Gujarat.

The north-western part of Rajasthan forms a part of the sandy desert known as 'Thar', which covers an area of 1,68,458 sq. km. The south eastern part is a hilly area. This includes the range of the Arawalis. The eastern and central parts of Rajasthan form the plain and plateau areas of the State. The total area of Rajasthan is 3,42,274 sq.km. Its population is nearly 41.6 millions with a density of 120 persons per sq.km.

Before the independence of India in 1947, there were nearly twenty-two princely states. These were later merged into the State of Rajasthan. In those princely states, very few educational facilities were available and the few schools in the capital cities of those states were not well equipped. Education was given only to the well-to-do. The masses had virtually no opportunity to educate themselves.

The creation of Rajasthan in its present form was completed in 1950. Since then, strenuous efforts have been made to expand educational facilities in the state, the result of which has been a vast increase in the number of students, in the number of teachers and in the number of schools. Moreover the percentage of enrolment of the school-going age group has considerably increased, and even those who are unable to join schools for whatever reason have facilities to attend the non-formal education centres. There is now a widespread awakening in the state, and people have become deeply interested in educating their children.

Besides the quantitative improvement, efforts have also been made to secure improvement in the quality of school education. In the areas of curriculum, textbooks, teaching aids, evaluation etc., research is carried out with a view to improving their quality. Similarly, training programmes are organized to keep the teachers up-to-date and to equip them with teaching-learning strategies which make schooling a joyful activity.

Science education has received special attention during these years. It is regarded as a major subject area in elementary education and its curriculum and the instructional materials it needs receive constant attention.

The story of Rajasthan's quest for education, particularly science education, follows.

The role and responsibilities of the State Institute of Educational Research and Training (SIERT), Rajasthan

The State Institute of Educational Research and Training (SIERT), Rajasthan, is essentially the academic wing of the Department of Primary and Secondary Education of the State of Rajasthan. It was formed in 1978 by the amalgamation of eight previously existing institutions, the State Institute of Education (SIE), the State Institute of Science Education (SISE), the State Institute of Language Studies, the Department of Correspondence Courses, the Audio-Visual Education Unit, the State Bureau of Educational and Vocational Guidance, the State Education Evaluation Unit and the Educational Technology Cell.

The various academic aspects of school education, previously looked after by these separate institutions, were re-organized to avoid duplication and to accelerate the pace of qualitative improvement. Within SIERT, separate divisions were set up and given the responsibility of planning and implementing their relevant activities and programmes. Thus there are divisions for Humanities and Social Sciences, Science and Mathematics, Psychological Foundations, Teacher Education and Correspondence Courses, Educational Administration, Supervision and Planning, Educational Technology, Language Studies and Non-formal education.

In addition, special units have been formed to implement specific projects under the academic guidance of the National Council for Educational Research and Training (NCERT), New Delhi. They, at present, comprise units for nutrition, health education and environmental sanitation, for primary curriculum development, for development activities in community education and participation, for early childhood education, for comprehensive access to primary education, for population education and for the integrated education of disabled children.

The tasks assigned to SIERT are to: evolve strategies for achieving the aims of universal elementary education; popularize and modernize science education so as to ensure understanding of its permanent importance in life; adapt the curricula, the text-books and the teaching-learning materials to the fast-changing needs and requirements of society and the nation; revitalize the teacher education programme and keep the teachers continually in touch with the latest trends in the field of education; identify talent in Rajasthan and to ensure its full development; conduct research in the field of school education relevant to future planning; and modernize education through the use of mass media.

The Institute works in collaboration with national and international agencies such as NCERT (New Delhi), the Centre for Cultural Resources and Training (New Delhi), the Rajasthan Board of Secondary Education, the National Council for Teacher Education (New Delhi), the Central Institute of English and Foreign Languages (Hyderabad), the Central Institute of Indian Languages (Mysore), the United Nations Children's Fund (UNICEF), the United Nations Fund for Population Activities (UNFPA) and others. In this way, it keeps abreast of the latest developments in the field of education at both national and international levels.

One of the main aims of SIERT is to assist the teachers to improve their teaching-learning strategies thereby improving the quality of instruction imparted to the students. The Institute, therefore, keeps itself constantly in touch with the schools and with the elementary school teachers in the State of Rajasthan. It is fully aware of school conditions, their needs and the abilities of the teachers working in them. The programmes of SIERT are, therefore, need-based and teacher-oriented.

Activities and programmes in the field of science education

As has been explained above, responsibility for the subject areas of the curriculum are assigned to the various divisions of SIERT. Education in science is given special emphasis and the many science education activities in the State are the main concerns of the division responsible. For the sake of convenience, these activities have been divided into three categories, namely curriculum development and the production of teaching materials, the training of science teachers and the use of materials developed.

The *curriculum* and the *teaching materials* are vital instruments both for pupils and teachers. The qualitative aspects of education depend, to a large extent, upon them. They not only quench the pupils' thirst for knowledge and impart the desired skills, but they also motivate students to pursue their studies further. This is particularly pertinent as regards instructional materials used to develop the skills of observation, discrimination, analysis and application. The first systematic curriculum for science in the elementary schools in the state, developed in 1962, emphasized factual aspects.

The 1970s are regarded in retrospect as an epoch-making decade in the educational history of Rajasthan. The State Institute of Education and allied institutions, such as the State Institute of Science Education, the Evaluation Unit, the Audio Visual Education Unit, etc. were established during this decade with a view to bringing about qualitative improvement in school education through various specified functions and activities. In this process, it was felt imperative to change the curricula then existing, including science. The then State Institute of Science Education (SISE) was made responsible for developing the new curricula and the work was entrusted to the curriculum cell of the Institute and to a high-powered committee with responsibility for reviewing and finalizing the curriculum of the elementary stage as a whole.

SISE, with the help of curriculum experts, scientists and science teachers from rural as well as urban areas of Rajasthan designed and developed the new curriculum for science in the year 1972. Their work gave a new dimension to science education, particularly to the teaching-learning activities which included experimentation. This curriculum remained in force until 1983.

With the formation of SIERT in 1978, new vistas were opened in all areas of elementary education. It was felt that the curriculum of elementary school education, particularly science education, required change, and at this juncture the UNICEF-assisted project was proposed. This sought to introduced a scientific and systematic procedure for developing instructional material for primary schools. The proposed project was taken up.

In the pilot phase of the project, thirty schools of three districts, Banswara, Bhilwara and Jodhpur, were involved. In the exapansion phase, three more districts, Alwar, Nagaur and Kota were included and the total number of schools was raised to 130. The districts and the schools so chosen were representative of the hilly, tribal, desert and industrial areas of the State. The development of materials for the project was preceded by a socio-economic and educational survey of the communities of the project areas to ensure that the curriculum and instructional matrials were need-based. Another feature of the procedure adopted was that the teachers, the teacher-educators, the supervisors, the subject specialists and the experts from NCERT and the Regional College in Ajmer were all involved in developing the curriculum and the instructional materials. Eventually, the new curriculum and instructional materials were introduced in the state system in 1984, after having been evaluated rationally and empirically, and modified accordingly.

While the primary school curriculum was thus being renewed, the curriculum for science education in the upper primary schools was also under scrutiny, and eventually a new model curriculum was developed by SIERT, involving again the active participation of teachers, teacher-educators and specialists in the field of science and technology. It has been the policy of SIERT to develop and produce textbooks in collaboration with teachers using workshops. The process involves some nine stages: the development of an outline for the textbook and some model lessons (six-day workshop); the identification and appointment of writers; a review of the first sequence of lessons developed by the writers with suggestions for their modification (six-day workshop, for writers and experts); the writing and rewriting of lessons; a second review with modification of lessons (six-day workshop); the development of designs and illustrations in a workshop of three to six days duration; a review of the complete book by experts and subject specialists (six-day workshop); the try-out and evaluation of the experimental edition; and printing, publication, production and distribution. The books so developed have been in use for a few years; they have earned gratifying appreciation from teachers (see Appendix 2).

The special features of the textbooks introduced in 1984 derive from their innovative approach. Whereas stress had previously been placed upon *learning* the facts, the newer books have been designed to assist the learner to *understand* the whole process of science, namely observation, identification, experimentation, analysis, synthesis, collection, classification, conclusion, etc.

Further renewals are contemplated as a consequence of the *National Policy on Education* promulgated in 1986. This stressed the need for a national system of education which pays greater attention to science and technology. In particular, the *National Policy* has emphasized the need to develop in children a 'spirit of inquiry, creativity, objectivity, the courage to question and an aesthetic sensibility' using the environment of the child as the learning milieu.

The elementary school curriculum at both stages, primary and upper primary, is being reviewed accordingly. A syllabus has been framed with the aim of imparting conceptual knowledge and inculcating a scientific attitude towards reality as well as an awareness of ecological and environmental problems and of how science can help to solve these problems.

In the process of developing the new curriculum the essential learning competencies, regarded as the major determinants of the content of the curriculum, have been determined and the following areas have been included in the elementary curriculum: the living world; the human body, nutrition and health; housing and clothing; air, water and weather; matter and its characteristics; soil and rocks; our earth and sky; force, motion and energy; natural resources; and our scientists.

SIERT is now making necessary preparation for the production of new textbooks, including workbooks and teachers' guides.

India is a developing country and cannot afford major expenditure on sophisticated teaching aids and apparatus for the teaching of science and allied subjects. SIERT, therefore, has developed *low-cost teaching aids* and *improvised apparatus* with a view to helping teachers to demonstrate effectively the ideas and the more difficult concepts of science.

Low-cost teaching aids, prepared from locally available materials, have been found very helpful. Moreover, the pupils themselves take an active part in preparing them. So far, two kits of low-cost teaching aids, one for science and the other for mathematics, have been developed and distributed to 7,000 state primary schools. These kits appear to give results as accurate as those of more sophisticated, costly kits. Moreover, they are repairable with locally-available materials.

In the rural areas of Rajasthan, the teachers find it very difficult to explain certain geographical features and natural phenomena with which the pupils are not acquainted. Realizing this difficulty, SIERT decided to develop a range of *tape-slide programmes*. The first was a programme on the universe called 'Brahmand Jaisa Hamne Paya'.

Lectures in all elementary-school teacher-training institutions have been given instruction in the use of this tape-slide programme which they hand on to the trainee-teachers. Two other programmes concerning population education have also been developed.

SIERT is now contemplating the possibility of developing more programmes for the use of teachers in the elementary schools and in state non-formal education centres.

Video is a powerful and attractive medium of communication. It has proved a very successful means of propagating simple ideas relating to science in a very interesting way. SIERT has recorded a number of *video-cassette programmes* for presentation in rural areas which have been used in primary schools and in non-formal education centres. It has been found that the information and concepts propagated using tape-cassettes have been easily grasped by students and by rural people. Efforts are being made to record more of these programmes, keeping particularly in view the needs of rural people. SIERT has also established a video-cassette library in its Community Science Centre whence the cassettes are borrowed by the schools and by other developmental agencies in the villages. (A list of programmes so far recorded is given in Appendix 3.)

Teacher training

The quality of education depends on the quality of teachers. It is said in the report of the Education Commission (1964-66) that 'Of all the different factors which influence the quality of education and its contribution to national development, the quality, competence and character of teachers are undoubtedly the most significant'. The training of teachers is one of SIERT's main functions. Training and orientation programmes are organized by and under the auspices of SIERT in various subjects, including science and mathematics. The training programmes are of two types. The first are those organized as regular features, whose main objective is to train teachers in the methods and techniques of teaching. The second are those acquainting teachers with innovative ideas or training them in the use of some new instructional materials developed by SIERT or similar institutions.

Science in modern times is regarded as one of the most important subject areas in the curriculum. It is accepted that improvement in science education at every level should be given prominence in our activities and programmes. SIERT believes that relevent training and retraining of teachers of science and mathematics should go hand in hand with curriculum development. Accordingly various courses for different categories of teachers have evolved over the years; they are briefly described below.

With a view to improving the quality of instruction in science and mathematics, *short-term training courses* are organized under the auspices of SIERT and the supervision of district education officers. SIERT draws up the syllabuses and provides academic guidance to their supervisors and administrators. The six-day courses are for teachers in primary and upper primary schools. Every year twelve to fifteen such courses are organized in different districts of the state.

The main objective of the short course is to acquaint the teachers with innovative ideas and new methods of teaching. As well as giving consideration to the methods and techniques of teaching, content of the instructional materials is also dealt with in these courses. The more difficult concepts of science and mathematics in the curriculum and the textbooks are explained. The teachers are introduced to low-cost teaching aids and the improvised apparatus developed by SIERT.

During the last seven years almost 10,000 teachers (6,000 mathematics teachers and 4,000 science teachers) have benefited from these courses.

During the vacation *summer camps* are organized for primary school teachers. The teachers are oriented towards the content of the instructional materials as well as the innovative methods and techniques of teaching science and mathematics. Efforts are made to impart laboratory and workshop skills which are essential if teaching is to be environmentally-oriented and activity-based. In these camps, before and after tests are given in order to assess training programme impact.

SIERT prepares the syllabus and trains the resource persons for these camps. During these training programmes, academic guidance is provided by SIERT experts through supervision and the dissemination of literature developed for the purpose. Every year four to ten summer camps are organized in different places with good laboratory and library facilities. During the last seven years as many as 1,800 science and mathematics teachers have been trained in these camps.

Every secondary and higher secondary school in Rajasthan employs a laboratory assistant, and with the introduction of new methods of teaching science, the responsibilities of the laboratory assistants have increased. To help them meet these new responsibilities, six *training workshops for laboratory assistants* are organized every year dealing with the role and responsibilities of the job (purchasing and maintaining stock registers of all items of equipment, chemicals and other materials), maintenance and use of laboratory equipment, particularly improvised apparatus and low-cost materials, and the experiments in the syllabuses of secondary and higher secondary classes. These programmes trained over 300 laboratory assistants in seven years.

With the introduction into schools of kits of apparatus for mathematics, *training in the use of kits* became obligatory. For this, a two-tier system has been evolved. SIERT trains resource persons, who, in turn, train primary-school teachers in programmes organized by the district education officers.

In the orientation programme for the resource persons, participants discover the problems of teaching science in the rural areas of Rajasthan and realize the need for improvisation as far as teaching aids are concerned. The different items of the kits are explained and training is given in the development of low-cost teaching aids from the materials available in their own locality. Some 150 resource persons have been trained by SIERT: all college lecturers, NCERT, has developed a Science Club kit to help science teachers and students to prepare models for science exhibitions. Two SIERT officers have been trained by NCERT in the use of this kit. NCERT has also provided forty-four kits for distribution in the secondary and higher secondary schools of Rajasthan and SIERT has organized training programmes for the teachers of the schools

to whom these kits were given, and they, in their turn, will disseminate the ideas behind the science club kit to other schools.

The kits were distributed only to those higher secondary schools which are central schools for school complexes, but all the sister schools of the complex have benefited. Three training courses have so far been organized and forty-four resource persons attended them.

Improvisation, as mentioned earlier, has played a vital role in the area of science education in Rajasthan. With improvised apparatus, teachers have been able to explain to students the more difficult concepts and principles of science. SIERT has not only prepared improvised apparatus but has also *trained teachers in the use of improvised apparatus*. To do so, SIERT has organized training workshops for teachers of primary, upper primary, secondary and higher secondary schools.

In these training workshops, emphasis is placed on the value of going deeply into natural phenomena and understanding the underlying principles of cause and effect. This helps teachers to search with greater confidence for the scientific principles present in their own environment and prompts them to devise their own apparatus using local materials. So far, 137 teachers have been trained as resource persons in the use of improvised apparatuses.

Finally, mention must be made of a *workshop on teaching science through laboratory activity method* organized in SIERT under the All India Science Education Programme (AISEP) in collaboration with the British Council. The main objective of this workshop and its follow-up programme was to disseminate the latest trends of science education adopted in the United Kingdom. In this ten-day workshop-cum-training programme, 44 postgraduate teachers from different districts of Rajasthan were brought together. An expert was provided by the British Council to act as tutor for the course. He, together with nine resource persons, previously trained in the United Kingdom for AISEP courses plus three other British experts worked with the participants on trends in science applicable to the higher secondary level of schooling in India.

Other activities

Besides developing curricula and instructional materials in the field of science education and organizing training programmes for science teachers, SIERT organizes a number of other activities which are conducive to better science education. A brief account of some of them follows.

Science exhibitions play an important role in encouraging youth to realize the relevance of science to society and the responsibility of the scientists of tomorrow. They offer exciting challenges to creativity and innovations which could solve some of the socio-economic problems, particularly those which relate to the rural population.

The exhibitions are infectious and they motivate children and teachers to design and develop something new and novel. They also help to popularize science and increase public awareness.

In India, science exhibitions are organized at four levels: school, district, state and national. At district and state levels, the responsibilities of organizing exhibitions and providing academic guidance to the teachers and students lies with SIERT. A number of exhibits from Rajasthan have been selected for national-level exhibition during the last ten years. In this connection, SIERT organizes a four-day workshop every year for those students who are selected for the national level exhibition with a view to helping them improve qualitatively their exhibits. In this workshop, necessary changes and modifications to exhibits are made and display cards are prepared by the students under the guidance of resource persons.

The *Science Seminar for secondary school students* is one of SIERT's most important activities. In this programme, students compete in a discussion of current problems of the environment. They make a thorough study of the topic chosen for the purpose and express and exchange their views on the topic at the seminar. The seminar's main objective is to develop a spirit of scientific enquiry and analytical thinking in young students.

The competition is held at three levels, district, state and finally national. The first seven winners of the state competition are awarded handsome prizes in the form of books on science. The performance of Rajasthan students participating at the national level has been quite satisfactory.

At the national level, a National Talent Search Examination is organized by NCERT, in which selected talented students of the state take part and successful candidates are awarded scholarships.

Some of the schools in rural Rajasthan are either ill-equipped or do not possess well qualified staff. Even where qualified staff and adequate equipment are available, talented students sometimes remain neglected due to overcrowded classes. When it was realized that a large number of talented students, for want of proper guidance, could not take advantage of the scheme, SIERT decided to organize *coaching camps* for them. These coaching camps are organized in the summer in different parts of the state and are staffed by highly qualified, experienced and talented lecturers from colleges of education. The curriculum for these camps was developed by SIERT and the camps are becoming more and more popular. They have proved successful in that they have helped to increase the number of successful students at the national level.

Science education, being an important component of the education system, should help to develop the understanding, skills, abilities and attitudes which are needed to solve the problems. Efforts are made to encourage problem-solving behaviour of students through *State Science Quiz Competitions*. The competition is organized every year by SIERT. Students compete in teams of two and the competition is organized at district and then state level. The first, second and third winners of the competition are awarded prizes.

SIERT also organizes at state level an *essay writing competition* for secondary and higher secondary students of science. The main objectives of this competition are to encourage students to probe into broader aspects of science, to identify students who have an ability for creative writing in science, to encourage students to express themselves in lucid, forceful and appropriate language, to nurture ability in creative writing, to encourage students to think hard about various aspects of science and technology, and to make a contribution to the solution of practical problems.

The competition, organized at district, then state and finally national level, is restricted to written entries only. These are divided into two categories: essay writing where graphs and scientific illustrations are allowed; creative writing which can include poems, plays, short stories, science fiction, etc.

At the district level, the topics are circulated by the district education officer. The district winners are then invited to enter for the state level competition, where an 'on-the-spot' essay writing competition is organized. Winners receive prizes and are invited to go on to the national competition.

Pollution of the environment is one of the crucial problems of modern times and to help combat it, SIERT organizes twelve to fifteen *ECO Development Camps* at different locations in Rajasthan which aim to develop awareness among the public and to provide guidance on environmental sanitation.

Students take a lively interest in these camps and local people are very co-operative and enthusiastic, participating fully in the activities. Wherever the camps have been organized, changes in the attitudes and habits of the people are noticed. For instance, dustbins have appeared outside every house, streets get cleaned, the drainage system in the village is improved and people become interested in using solar energy for cooking. They are often motivated to use it and thus to conserve forest fuel.

The science teachers of the upper primary classes do not generally have an opportunity to show how well they can teach. Moreover, their teaching can become stereotyped if they do not get the chance to experiment and to use innovative practices in class. With a view to giving science teachers an opportunity to display their talents, SIERT organizes an annual *Science Teaching Competition* to encourage among all teachers an interest in teaching science through demonstrations and experimentation and a skill in improving apparatus using locally available materials, and to help teachers to realize fully their capacities, talent and potential and make them more self confident in tackling the problems which arise in the classroom.

The competition is organized at the district and the state levels, where the first three winners are awarded prizes.

SIERT organizes three-day *Environmental Training Programmes* twice a year for teachers and district level officers. This training is important in that it aims to make teachers and officers aware of their own responsibilities for improving the environmental condition of the locality in which they live. Lectures are given on different aspects of the environment and films are shown on the subject. Transparencies and slides, especially developed for the purpose, are also shown. Visits are made to places which present specific environmental problems such as water pollution and air pollution, as well as to places which present examples of excellent environmental conditions such as thick forests, gardens and areas with good sanitary facilities. Participants are also taught about the need for environmental improvement through cleaning, sanitation, plantation and the proper maintenance of good conditions.

The teaching of science can be effective in the primary schools only if proper facilities are provided. In the National Policy on Education emphasis is laid on providing essential facilities in the primary schools. *Operation Black Board* ensures the provision of minimum essential facilities in primary schools. The word 'Operation' implies the urgency in this programme. Its goals are clear and well defined, and the Government and people are determined to achieve these goals within a particular period of time. In connection with this programme, SIERT has developed prototypes of the required materials together with specifications for making them. These minimum essentials are listed in Appendix 4.

With a view to arousing scientific awareness among the public at large, a *Community Science Centre* has been set up by the Institute. It is located in Sahelion-Ki-Bari, the most beautiful of the tourist attractions in Udaipur. Hundreds of visitors come every day to visit the Centre, a tribute to its success in popularizing science. New dimensions have been added by involving rural people in various activities of the Centre in the area of science and technology. For example, there is a six-day *Guidance programme for school children* which provides training in model making. On the first day the students visit the Science Centre. On the second they prepare designs for their model. On the third day instruction is given on making models. Subsequently students make their models and write their reports. These are displayed in the demonstration room of the centre. Then there is a programme entitled *Science towards the village* which aims at awakening villagers to science, using the Science Centre. The programme has been very successful, with the villagers showing a lively interest in its activities.

Special attention to *health and nutrition* features prominently in primary education. It is believed that teaching desirable nutrition, health and sanitation practices may eradicate or at least considerably reduce many of the common illnesses prevalent in rural communities. This is particularly true in the tribal areas. The project 'Nutrition, Health Education and Environmental Sanitation' (NHEES) implemented by SIERT in two blocks of the Udaipur district of Rajasthan aims to put the relevant ideas into practice. The scheme is designed to help teachers to integrate the concepts of nutrition, health education and environmental sanitation into primary education. The project involves preparing, testing and developing packages of instructional materials, creating an awareness of the importance of nutrition, health education and environmental sanitation by conducting meetings in the community, and testing and devising means by which nutrition and health education can be brought to the out-of-school population, especially to women and girls in underprivileged groups such as the unscheduled castes and the scheduled tribes.

Appendix 1

List of Publications

A - Books

1. *Asurachit Upkaran Nirman Sandarshika* [Guidebook on Improvised Apparatus].
2. *Prathmik Vigyan Kit Sandarshika* [Guidebook on Primary Science Kit].
3. *Anusandhan Prayojana Pustika* [Booklet on Investigatory Projects].
4. *Mansik Yogyata Prashna-kosh Sandarshika* [Guidebook for Question Bank on Mental Ability].
5. *Adhyapak Sandarshika - Samanya Vigyan* [Teachers' Guidebook on General Science for Classes 1-5].
6. *Poshan, Swasthya Shiksha Aur Paryavarn Swachhata - Kaksha III* [Nutrition, Health Education and Environmental Sanitation - Class III].
7. *Poshan, Swasthy Shiksha Aur Paryavarn Swachhata - Kaksha IV* [Nutrition, Health Education and Environmental Sanitation - Class IV].
8. *Poshan, Swasthya Shiksha Aur Paryavarn Swachhata - Kaksha V* [Nutrition, Health Education and Environmental Sanitation - Class V].

B - Pamphlets and Posters

1. Ratondhy (Night Blindness)
2. Radha Ka Parenda (Radha's Water-hut)
3. Mal Ka Tyag Kahan Kare (Where to Defecate?)
4. Shauchalays Se labh Uthayen (Get benefit from Lavatory)
5. Hand Pump Ka Upyog Kaise karen (How to use Hand Pump)
6. Kai Samsyaen Ek hal-Soak Pit (One solution to many problems - soak pit)
7. Poorak Ahar - Vikas Ka Adhar (Supplementary Food is the Base of Development)
8. Naroo Rog (Guinea Worm)
9. Malaria
10. Cancer
11. Hamare Jal Sadhan (Sources of Water)
12. Sabjiyan Sukhaiye, Varsh Bhar Khaiye (Eat dry vegetables throughout the year)
13. Pashuon Ka Than (Cattle Shed)
14. Ma Ka Doodh (Mother's Milk)
15. Bachhe Ki Dekh Bhal (Child Care)
16. Teeke Lagwaeyen (Immunize your Child)
17. Naroo Se Bachiye (Prevention of Guinea Worm)
18. Jal Srot Ko Saf Rakhen (Keep water sources clean)
19. Ghar Gaon Ko Saf Rakhe (Keep Your Home and Village Clean)
20. Hamari Aukhen (Our Eyes)
21. Bhojan Ke Moolbhut Samuh (Basic Food Groups)
22. Paryavaran Saaf Suthra Rakhen (Keep your Environment Clean)

Appendix 2

List of textbooks developed by SIERT in the field of

Science Education for wider use in the state system of education

No.	Book	Year of Publication
1.	Vigyan-Kaksha III (A Textbook of Science for Class III)	1970
2.	Vigyan-Kaksha - IV (A Textbook of Science for Class-IV)	1071
3.	Vigyan-Kaksha V (A Textbook of Science for Class V)	1972
4.	Vigyan-Kaksha VI (A Textbook of Science for Class VI)	1971
5.	Vigyan-Kaksha VII (A Textbook of Science for Class VII)	1971
6.	Vigyan-Kaksha VIII (A Textbook of Science for Class VIII)	1972
7.	Ganit-Kaksha III (A Textbook of Mathematics for Class III)	1984
8.	Ganit-Kaksha IV (A Textbook of Mathematics for Class IV)	1984
9.	Ganit-Kaksha V (A Textbook of Mathematics for Class V)	1985
10.	Paryavaran Adhyayan II - Vigyan Kaksha III (A Textbook of Science for Class III)	1984
11.	Paryavaran Adhyayan II Vigyan Kaksha IV (A Textbook of Science for Class IV)	1985
12.	Paryavaran Adhyayan II - Vigyan Kaksha V (A Textbook of Science for Class V)	1987

Appendix 3

List of Video Cassette Programmes

No.	Title	Duration (minutes)
For children		
1.	Darpan (Looking Glass)	12
2.	Gautam Aur Gauri Ka Pump	21
3.	The Earth	05
4.	Ped Paudhon Se Poshan (Nutrition by Trees and Plants)	10
5.	Ped Paudhon Ki Jad	07
6.	Ped Paudhon Se Ahaar (Food from the Trees and Plants)	10
7.	Ped Poudhe Tarah Tarah Ke (Varieties of Trees and Plants)	14
8.	What is Rain?	09
9.	Lantern	10
10.	Ek Aur Ghar Pani (Water to one more House)	10
11.	Tairak Pakshee (Birds that can swim)	10
12.	Adha Chauthayee (Half and one fourth)	12
13.	Solid Shapes	09
14.	Ankon Ka Jadu (Magic of numbers)	13
15.	Volume	10
16.	Distance	09
17.	Area	11
18.	Weight	10
For Teachers		
1.	Low Cost Teaching Aids - I	21
2.	Low Cost Teaching Aids - II	21
3.	Low Cost Teaching Aids - III	21
4.	Low Cost Teaching Aids - IV	21
5.	Low Cost Teaching Aids - V	21
6.	Low Cost Teaching Aids - VI	20
7.	Making the Toys with Rubber Sole	26

Appendix 4

Essential Facilities to be Provided to a Primary School

Under the Blackboard Operation Scheme

I. Teachers' equipment

a) Syllabus
b) Textbooks
c) Teachers' guides

II. Classroom Teaching Materials

a) Maps:
  i) District
  ii) State
  iii) Country
  iv) World
b) Plastic globes
c) Educational charts

III. Play materials and toys

a) Wisdom Blocks
b) Surface Tension
c) Bird and Animal Puzzles
d) Animal World
e) Balance and Weights
f) Magnifying Glasses
g) Magnets
h) Measuring Tape
i) Charts of cleanliness, nutrition, language and number

IV. Games equipment

a) Skipping rope
b) Balls
  1. Football
  2. Volleyball
  3. Rubber balls
c) Air pump
d) Ring
e) Swing Rope with Tyre

V. Primary Science Kit and Primary mathematics Kit

VI. Mini Tool Kit

VII. Two in one audio equipment

VIII. Books for Library

a) Reference Books
   i) Dictionaries
   ii) Encyclopaedia
b) Children's Books (at least 200)
c) Magazine, Journals and Newspapers for Teachers and Children

IX. School Bell

X. Musical Instruments

a) Dholak or Tabla
b) Harmonium
c) Manjira

XI. Contingency Money with Teachers

XII. All weather classrooms

a) Classrooms
b) Toilets - one for boys and one for girls
c) mats and furnitue for students and teachers

XIII. Blackboard

XIV. Chalk and duster

XV. Water facility

XVI. Trash can

Appendix 5

Examples of and Extracts from Teaching Materials

Details regarding the development of teaching materials by SIERT for the elementary school education have been given in Chapter 3. Examples of teaching materials other than textbooks and extracts from the textbooks of science for the primary school education make up the content of this chapter. They present an overall view of the quality of the instructional materials developed by SIERT. Examples of low-cost teaching aids include the Primary Science Kit and the Primary mathematics Kit developed by SIERT for primary school. Examples of improvised apparatus include items which are useful in teaching science to the pupils of elementary education. Extracts from the instructional materials include three lessons from science textbooks for classes III, IV and V.

I. Low cost teaching aids

As explained earlier, the low-cost teaching aids have proved very helpful in making the difficult concepts of science easy for the students of elementary classes. The aids have been classified into two categories, i.e. aids for teaching science and those for teaching mathematics, thus, two kits have been developed, the primary science kit and the primary mathematics kits.

Items included in the science kit and their utility in conducting experiments during teaching-learning process

		Utility in activity/Experiment
1	Thermometer	Temperature measurement
2	Magnifying glass	Study of different shapes and sizes of soil crystalsand cells; feeding and respiration in insects
3	Measuring cylinder	Measuring volume of liquids and irregular solids
4	Plastic funnel	Filtration, photosynthesis and stethoscope
5	Plastic water wheel	Conversion of steam energy into mechanical energy Transformation of falling water and blowing wind energy into mechanical energy.
6	Tripod stand	Keeping the vessel for heating.
7	Plastic syringe	Demonstration of air pressure; measurement of volume of liquid.
8	Torch bulb with holder	Demonstration of conversion of electrical energy into light energy.
9	Plastic tube	Demonsrtration of light travelling in a straight line; transferring water from one vessel to another.

10	Pin	General use, as in demonstration of magnetic force
11	Enamelled copper wire	Demonstration of the transfer of electrical energy into light energy.
12	Iron spring	Make use of force, preparation of spring balance.
13	Simple balance	Weighing materials.
14	Weights	Measuring the weight of different materials.
15	Rubber ball	Demonstration of the rotation of earth; formation of day and night; revolution of earth around the sun, showing the different positions of earth; circular shadow of spherical bodies; lunar eclipse, solar eclipse, phases of moon.
16	Aluminium bowls	Used as vessel, for demonstration of melting ice and its conversion into water, heating the water and other materials solubility of different materials, etc.
17	Teaspoon	Stirring.
18	Talcum powder, empty box	Demonstration of water pressure at different depths
19	Thread	Demonstration of the expansion of solids due to heat
20	Cork	Demonstration of floating.
21	Pulley	Demonstration of the concept of how a pulley helps.
22	Plane mirror	Reflection of light.
23	Glass bottle	Used as vessel in demonstrating air occupying space, absorption of water and minerals from root to leaves, preparation of small aquarium, respiration in germinating seeds, collection of plants and insects and upward movement of hot air.
24	Iron nails	General use.
25	Magnetic needles	Demonstration of magnetic properties; preparation of compass needle.
26	Fused bulb	Used as vessel, magnifying lens; demonstration of explansion of liquid and gases.
27	Dry cell	Conversion of electrical energy into light energy, use of electricity in different ways.
28	Scale	Measuring length, width and height; demonstration of air pressure.
29	Overflow vessel	Measurement of volume of irregular bodies, weight of bodies in water, force of bouyancy.
30	Straw	Demonstration of air pressure in upward directin, to suck the water.
31	Balloon	Preparation of stethoscope and model of lungs demonstrate that air occupies the space.

32	Polythene bag	Used for demonstration of transpiration (in plants).
33	Rubber band	Properties of elasticity, preparation of improvised balance.
34	Cycle spoke	Used axis of water wheel.
35	Candle	Used for heating, demonstration of expansion of solid, liquid and gases, evaporation, solubility.
36	Iron fillings	Demonstration of magnetic force separation of iron fillings from mixture.
37	Potassium permangnate	Solubility at different temperature, movement of molecules, expansion of liquids.
38	Sugar	Demonstration of solubility of sugar at different temperatures, shape and size of crystals.
39	Juggery	Observation of slow solubility of juggery in water.
40	Sawdust	Observation of insolubility of sawdust in water.
41	Ink tablets	Observation of solubility in water.
42	Cardboard	Preparation of improvised apparatus showing expansion of solids, demonstration of upward movement of hot air.
43	Matchbox	Used in burning.
44	Jute thread	Preparation of bow, used to tie things.
45	Fragrance sticks	Demonstration of upward movement of hot air, diffusion of gases.
46	Glass/marble balls	Demonstration of friction force, inter-molecular space.
47	Spin wheel toy	Rotation of earth on its axis.
48	Open mouth tin box with small hole (cubic shape)	Demonstration of water pressure.
49	Cotton	Separation of suspended particles from water.
50	Wooden tray	Used to keep the items in systematic manner.

Items included in the mathematics kit and their utility in conducting experiments during teaching-learning process

		Utility in activity/experiment
1	Geometrical shapes (three dimensional) including cube, cuboid cylinder, sphere and cone	Explaining the idea of different shapes and sizes of solid objects.
2	Geometrical shapes (two dimensional), including square, rectangle, circle and triangles.	Explaining the idea of different shapes and sizes of solid objects.

3	Model clock	Learning to tell the time.
4	Fraction plate, fraction disc, decimal fraction strips.	Explaining the concepts of decimal, numerator and denominator in various types of fractions.
5	Half meter scale	Measuring length, breadth and height.
6	Cuisenaire strips and napier strips.	Explaining multiplication.
7	One set of international and Roman letters.	Numbers from one to twelve in Roman letters.
8	Spike abacus	Explaining the concept of units, tens, hundreds, thousands and ten thousands.
9	Geometrical	Drawing different types of two-dimensional figures.